Level of Effectiveness of the Implementation of Transport Demand Management (TDM) Strategy in Indonesian Cities

Iwan P KUSUMANTORO
Researcher
Institut Teknologi Bandung
Gd. Labtek IX A Lt. 5
Jl. Ganesha 10 Bandung 40132 Indonesia
Phone: +62-22-2504735 ext 3611
Fax: +62-22-2501263
Email: ipkus@pl.itb.ac.id

Erli MARTHA
Researcher
Institut Teknologi Bandung
Gd. Labtek IX A Lt. 5
Jl. Ganesha 10 Bandung 40132 Indonesia
Phone: +62-22-2504735 ext 3611
Fax: +62-22-2501263
Email: pradono@pl.itb.ac.id

Ibnu SYABRI
Associate Professor
Institut Teknologi Bandung
Gd. Labtek IX A Lt. 5
Jl. Ganesha 10 Bandung 40132 Indonesia
Phone: +62-22-2504735 ext 3611
Fax: +62-22-2501263
Email: syabri@pl.itb.ac.id

Desiree KIPUW
Researcher
Institut Teknologi Bandung
Gd. Labtek IX A Lt. 5
Jl. Ganesha 10 Bandung 40132 Indonesia
Phone: +62-22-2504735 ext 3611
Fax: +62-22-2501263
Email: desiree@pl.itb.ac.id

Abstract: Congestion is a transportation problem faced by most of Indonesian large cities, including Bandung and Jakarta. In general, the problem of congestion in Indonesia is dealt with supply approach through the addition of new road network. This approach is no longer relevant after the emergence of TDM concept as a strategy to modifying trip demand. The implementation of TDM strategy in Indonesia is still rare. The importance of TDM, therefore, should be viewed on the effectiveness of TDM strategy in dealing with transportation problems in Indonesian cities. The implementation will be effective if there is a change in trip behavior and/or a change in trip demand. The result of the study shows that the level of effectiveness of the implementation of TDM strategy in Indonesia is influenced by the level of public acceptance, level of policy “coerciveness”, level of combination of various TDM strategies, level of trip users who are the target of TDM strategy policy, and level of promotion and education for the implementation of the TDM strategy.

Key Words: Effectiveness, Congestion, TDM (Transport Demand Management) Strategy

1. INTRODUCTION

The problem of congestion occurs in large cities in the world. The main cause of the problem is the imbalance between the supply of road network and trip demand with motor vehicle. In general, the approach conducted in dealing with this problem is by adding the supply of road network. However, this approach is no longer relevant due to limited supply of urban land and new problems as a result of the additional road network. In the end, the introduction of a ‘non-supply’ based concept or demand-based concept known as Transport Demand Management (TDM) in 1970s provided new nuance in dealing with the problem of congestion.

TDM is a general term for a strategy and program that encourages the use of transportation infrastructure more efficiently, or a method to influence the behavior of the traveler, with the purpose to reducing the needs of trips or to spreading the needs in time and space (Ferguson, 2000). In this TDM concept, limitation on the needs on transportation does not mean limitation on the number of trips, rather it is an approach to managing the process of those
trips processes in the effort to avoid trips occurring at the same time and/or at the same location (Ferguson, 2000).

TDM strategy has been implemented in cities in the world, especially in developed countries since this strategy was introduced in 1970s. The experiences show both the success and the failure of the implementation of the TDM strategy. The success and the failure of the implementation of the TDM strategy are influenced by many factors (Michael D. Meyer, 1999; Greg Stewart and Rob Pringle, 1997; Louise Eriksson et al., 2006; Neil Thorpe et al., 2000). Those factors will determine how far the TDM strategy will be effective in dealing with the transportation problem.

The implementation of TDM strategy in Indonesia is still rare, and even some municipal governments are still unfamiliar with the TDM strategy. Therefore, the importance of the role of TDM should be viewed on how far the strategies in TDM are capable of dealing with urban transportation problems. Based on this, research on the effectiveness of TDM is conducted with the purpose to assess more the effectiveness of the implementation of TDM strategy in responding to transportation problems in Indonesian cities. Cities chosen for this study are Bandung and Jakarta.

Evaluation on the effectiveness of TDM strategy is conducted on the type of TDM strategy that has been or has not been implemented. Through this evaluation, the goals to be achieved are 1) to identify indicators that will be the measurement of the effectiveness of the implementation of TDM strategy; 2) to assess the level of effectiveness of the implementation of TDM in dealing with transportation problems in road segments in the study areas; 3) to identify the obstacles to the implementation of TDM strategy; 4) to formulate conclusion that can provide relevant input to the development of transportation policy in cities of the case study, and in Indonesian cities in general.

The approaches used in this paper are quantitative and qualitative approaches. The method of data and information collection to support this approach is conducted literature study, secondary survey, and primary survey. The result of this study is expected to be able to provide benefits such as (i) show the level of effectiveness of the implementation of TDM strategy in dealing with the urban congestion problem; (ii) know various obstacles should be faced in implementing TDM strategy in Indonesian cities; (iii) Policy input as an input for the policy of dealing with Indonesia urban transportation problems.

2. FORMULATION OF THE EFFECTIVENESS OF TDM STRATEGY

The popularity of TDM in the world rise in the impact of the success of TDM strategy implementation in various world cities such as Cambridge, Singapore, Perth, Beijing, Dublin, Greater Vancouver Region, London, Trondheim, Southern California, Portland, and Auckland. The success of the TDM strategy implementation is viewed from the level of reduction of trip length (VMT – Vehicle Miles Traveled), reduction of congestion (reduction of vehicle volume in a road segment), reduction in emission (vehicle gas emission), shift in mode choice, etc., as shown in Table 1. The measurement of the success of TDM strategy implementation is different from one city to another, depending on 1) type of TDM strategy implemented, independently or as a combination; 2) at what level the TDM strategy is implemented, neighborhood level, city level, regional level, or metropolitan level; 3) who are the actors being targeted by the TDM strategy implementation, workers, household, educators, etc.
Table 1 Experiences of the effectiveness of the implementation of tdm strategy in various cities of the world

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Type of TDM Strategy</th>
<th>Effectiveness Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern California</td>
<td>Telecommuting</td>
<td>VMT reduction (91.1%), trips reduction (1.0%), CO2 emission reduction (1.0%) (Cameron, 1991; Harvey and Deakin, 1991)</td>
</tr>
<tr>
<td>Southern California</td>
<td>Increased and marginalized parking price</td>
<td>Through Parking Pricing, Work ($1/day) resulted in VMT reduction (1.0%), trips reduction (1.1%), CO2 emission reduction (1.1%) (Cameron, 1991; Harvey and Deakin, 1991)</td>
</tr>
<tr>
<td>Southern California</td>
<td>Increased and marginalized parking price</td>
<td>Through Parking Pricing, Non-Work, resulted in VMT reduction (4.2%), trips reduction (5.4%), CO2 emission reduction (4.6%) (Cameron, 1991; Harvey and Deakin, 1991)</td>
</tr>
<tr>
<td>USA</td>
<td>Carpools</td>
<td>Trip reduction (Wayne Berman and Laurel Radow, 1997)</td>
</tr>
<tr>
<td>USA</td>
<td>Vanpools</td>
<td>the lowest overall trip reduction performance and highest unit costs (Wayne Berman and Laurel Radow, 1997)</td>
</tr>
<tr>
<td>USA</td>
<td>Public transit</td>
<td>Trip reduction (Wayne Berman and Laurel Radow, 1997)</td>
</tr>
<tr>
<td>Auckland</td>
<td>Carpools</td>
<td>Carpool adjustment based on work force and program promotion can reduce trip up to 20%, but should be supported by financial incentive and parking management (Auckland Regional Council, 2000)</td>
</tr>
<tr>
<td>Auckland</td>
<td>Parking Management</td>
<td>Reduce vehicle trips 8-18% reduce the level of drive-alone around 2-5% (Auckland Regional Council, 2000)</td>
</tr>
</tbody>
</table>

Source: Adaptation from various literatures, 2008

The success of TDM strategy implementation is strongly influenced by various factors. Louise Erikssona et al. (2006) and Neil Thорpea et al. (2000) showed the importance of “public acceptance” in the success of TDM strategy implementation. In different time, Michael D. Meyer (1999) stated that the success of TDM strategy implementation strongly influences the relationship between incentive and/or disincentive program of the TDM strategy. Furthermore, the implementation of TDM strategy in Toronto according to Greg Stewart and Rob Pringle (1997) showed that the failure of TDM strategy implementation is the lack of political sensitivity in accelerating the changes of the behavior of the travelers to be able to understand and own knowledge on the importance of reducing the use of private vehicle. Other factors which have influences on the success of TDM strategy implementation are: 1) level of coerciveness of the implementation of TDM strategy to change “forcefully” the trip behavior; 2) level of publication or approach of introducing the TDM strategy to the public; 3) level of management of the implementation of a certain TDM strategy; 4) level of area of the TDM strategy implementation (local or regional) and the character of the travelers
workers, students or tourists). This level of success of the TDM strategy implementation will determine its level of effectiveness.

Measuring effectiveness is a difficult task and there is no basic standard as an indicator of the effectiveness of the TDM strategy implementation (Washington State Department of Transport, 2000). However, this can be approached through experiences of the effectiveness of TDM strategy implementation in the world and the objectives embedded in the TDM terminology. In line with the definition, an activity/program/strategy is considered effective if the implementation has reached the objectives set beforehand. Therefore, from the terminology point of view, there is a need to identify the objectives implicitly embedded in the TDM definitions. The following are some definitions stated by various literatures/experts:

1. Washington State Department of Transport (2000), TDM is a terminology applied to wide array of strategies oriented toward the reduction and modification of demand (use) of transportation system. Most of the TDM strategies are intended to modify trip behavior by using measurement that indicates reduction in the number of trips, to change travel time, or to accommodate trip with fewer vehicle trips.
2. Todd Litman (1000), TDM is an array of strategy with the purpose of enhancing trip choices and encouraging travelers to use the best choice for them.
3. Gifford and Stalebrink (2001). TDM is also defined as an umbrella terminology which is used to describe the diversity of actions in reducing or modifying demand on transportation service and facilities.
4. Michael D. Meyer (1997) stated that TDM is an array of action with the purpose of influencing travelers to be able to use alternative of mobility choice and to reduce congestion.
5. Ferguson (1997), TDM is a terminology to describe various techniques referred to the modification of trip behavior.

Based on the definition of the TDM concept, it is concluded that there are two main objectives of the TDM concepts:

1. Modifying trip demand by providing various trip choices alternatives through various types of TDM strategy. The type of this trip modification can be viewed from whether or not there is a change travel time, change in trip route, or change in the use of trip mode, etc. In principle, this objective influences the behavior of individual trip. This objective is adjusted with the actors that become the target of the implementation of TDM strategy.
2. Reducing trip demand, e.g. through reduction in trip length, reduction in the number of trip, and so forth. The objective is very measured and is usually part of the indication of reducing congestion as one of the transportation problems.

Based on the experience of TDM strategy implementation and the objective of the TDM concept, some indicators to show the effectiveness of TDM implementation strategy can be formulated. Some of the indicators are as follows:

1. Changes in trip behavior that can be qualitatively and quantitatively explained. For example, through the TDM strategy implementation in a location or city there is a shift in mode use or trip travel that can be explained qualitatively and quantitatively.
2. Reduction in the number of trips or reduction in the length of trips that can be measured aggregately from a location or city where the TDM strategy is implemented.

Various types of TDM strategy are classified by various literatures and experts with the purpose to simplify the naming of groups from various types of TDM strategy with similar characteristics. According to a research by SIWK (2007), the classification of TDM strategy
is divided into nine major categories, i.e.:

1. Managerial and Institutional contexts, is a group of strategy oriented toward managerial and institutional development of TDM, such as transportation financing strategy.
2. Rule/regulation, is a group of strategy oriented toward rule or regulation that encourages or limits trip, e.g. regulation to limit trip in the city center (Three in One policy).
3. Information provision, is a group of strategy oriented toward the development of information for travelers, such as Internet transport information.
4. Pricing and Tax, is a group of strategy oriented toward pricing and tax, such as road pricing or enhancing vehicle tax.
5. Land use strategy, a group of strategy oriented toward land use regulation, such as compact city development.
6. Public Transportation Mode, is a group of strategy oriented toward the provision of public transportation, such as the development of busway.
7. Non Motorized Mode, is a group of strategy that encourages non motorized trips through the provision of pedestrian way facility or the provision of bicycle lane.
8. Mode substitution, is a group of strategy oriented toward substituting trips or substituting the use of private and public modes, such as telecommuting or ridesharing (carpool, buspool, vanpool).
9. Innovation ideas, is a group of strategy that have uncommon characteristic “exotica” such as personal rapid transit. Mode Innovation Idea, is an uncommon type of strategy, “exotica”, such as personal rapid transit.

In this study, the types of TDM strategy that will analyzed its effectiveness of implementation in Indonesia are:

a. TDM strategy oriented toward rule/regulation: Three in One policy.
b. TDM strategy oriented toward pricing and tax: the enactment of progressive parking tariff in the city center.
c. TDM strategy oriented toward public transportation mode: busway, buslane.
d. TDM strategy oriented toward mode substitution: shuttle service, telework, carpool, buspool.

The selection of the type of strategy is based on the consideration that some of the strategies have been implemented in Indonesia, such as three in one and busway policies in Jakarta, shuttle service and telework in Bandung. In addition, some types of TDM strategies have not been implemented but have been simulated in Bandung, such as progressive parking tariff in the city center, buslane, carpool, and buspool.

3. ANALYSIS ON THE EFFECTIVENESS OF TDM STRATEGY IN THE STUDY AREA

Transportation problem is the basis of selecting the type of TDM strategy that will be implemented. Prior to conducting the analysis of the level of effectiveness of the TDM strategy implementation, it is important to identify the problem of transportation on several road segments in the study area (Bandung and Jakarta). The result of the identification can be seen on Table 2.

<table>
<thead>
<tr>
<th>City</th>
<th>Road Segment</th>
<th>Transportation Problem</th>
<th>TDM Approach</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandung</td>
<td>Bandung-Jakarta</td>
<td>Congestion on main</td>
<td>Shuttle service</td>
<td>Has been implemented</td>
</tr>
</tbody>
</table>
Table 2 shows that the main transportation problem in Bandung and Jakarta is congestion. This congestion problem is a result of high use of private vehicles, in addition to high road side fraction. Therefore, road network supply approach is no longer relevant due to limited urban physics and new problems resulted from the construction of the new road network. Some TDM strategies are implemented and simulated to find out a more relevant way of dealing with transportation problem and a strategy that is oriented toward the modification of trip demand. Table 3 shows the valuation of the effectiveness of the TDM strategy implementation on road segments listed on Table 2.
### Table 3 Evaluation on the effectiveness of the TDM strategy implementation on road segment in the study area

<table>
<thead>
<tr>
<th>No</th>
<th>Group of TDM</th>
<th>Type of TDM strategy</th>
<th>City of Implementation</th>
<th>Effectiveness measures</th>
</tr>
</thead>
</table>
| 1  | Rule/regulation | *Three in One* policy (occupancy of car limitation in peak hour) | Jakarta | a. Different choice of trip route during the enactment of *three in one*;  
b. Shift in trip time with the purpose to avoid the enactment of *three in one*;  
c. Common use of modes (ridesharing) with travelers with similar area of origin. |
| 2  | Pricing and tax | Progressive parking tariff in the city center | Bandung | a. Shift in mode use  
b. Shortening of activities time in the city center.  
c. Changes in trip frequency to the city center so that there is no piling up of trips at the same time. |
| 3  | Public transportation mode | *Busway* | Jakarta | a. The potency of mode shift from private mode to *busway* (30% of 50 respondents)  
b. Changes in road LOS on several road segments in Daan Mogot street, from F to D (total congestion to unstable flow) |
|    |              | *Buslane* | Bandung | a. Change in road LOS into A (free flow) from the existing LOS, i.e. B, C, and D.  
b. The potency of mode change from private mode to *buslane* (61.41% to 91.26%). |
| 4  | Mode substitution | *Shuttle service* | Bandung | a. Increase in the frequency of Jakarta-Bandung trip with “travel” mode as seen from the chance of the use of “travel” mode which is 0.72 relative to the chance of the use of private mode.  
b. Reduction in the frequency of the use of private vehicles from Jakarta-Bandung trip, except for a certain trip which mandated the traveler to arrive at the destination on time or conducting the trips together with the family. |
| 4  | Mode substitution | *Carpool* | Bandung | Voluntary development of *carpool* can reduce vehicle by 6%, which means that 100 private vehicle uses in middle school location can be reduced to 94 with voluntary carpooling. |
|    |              | *Buspool* | Bandung | a. The chance of a shift of private mode users to *buspool* (campus bus) only 38%, which means that trips with private vehicle can only be reduced by 38%.  
b. No significant changes in road LOS if assumed there is a reduction of 38% in the use of private vehicle. |
|    |              | *Telework* | Bandung | a. Reduction in the number of working trips especially during peak times due to the telework workers are not mandated to come to the office, but can work directly from other place or telecenter.  
b. Reduction in the frequency of working trip due to telework policy enacted on some... |
The valuation method of the effectiveness of the TDM strategy implementation based on Table 3 is done by quantitative and qualitative approaches. Quantitative approach is numerical calculation of travel behaviour change to the TDM group given and road LOS change. This approach is done by calculation of choice change probability based on the TDM group given and survey about road level of service (volume capacity ratio). Then, qualitative approach is identification of travel behaviour change quantitatively that done by preference and perception survey to the travel actors.

Based on the level of change of the trip behavior and road LOS as a result of the TDM strategy implementation, the level of effectiveness of each TDM strategy implementation can be classified into 3(three) categories, i.e.:

1. Less effective: carpool and buspool
2. Effective: shuttle service, buslane, and progressive parking tariff in the city center.
3. Quite effective: busway, three in one policy, and telework

The level of effectiveness of the TDM strategy implementation is influenced by the level of obstacles (both exogenous and endogenous) in implementing the TDM strategy. Some of the obstacles are:

A. TDM strategy oriented toward rule/regulation: Three in One policy
   - *Three in One* policy is not optimally integrated with the provision of busway mode which is capable of providing minimum services equal to that of private vehicles in terms of safety, comfort, and reliability/flexibility.
   - No combination with the type of TDM strategy which limits the use of private vehicles at household level, e.g. the enactment of progressive vehicle tax according to public economic and social status.

B. TDM strategy oriented toward pricing and tax: progressive parking tariff in the city center.
   - No combination with other relevant types of TDM strategy which encourage trips with alternative mode, e.g. the provision of workers bus integrally among various trade and service activities in the city center (*buspool*), the provision of *park and ride* strategy which enables people to park their vehicles far from the city center and to have access to the city center through inner city bus or non-motorized mode (*pedestrian way*).
• No regulation which regulates the legalization of parking tariff policy in the city center, and the management of parking by authorized institution. Currently, parking in Bandung is mostly conducted by ‘pungutan liar’ (illegal collection), most of which do not have the authority to collect parking fee so that parking management in Bandung is using inappropriate space for parking such as road shoulder and sidewalks.

C. TDM strategy oriented toward public transportation mode: busway, buslane
• Low preference toward busway mode because bus shelters are not well integrated with the residential location, including the unavailability of feeder to serve trips from the residential area or area of origin to the shelter.
• The provision of busway is not integrated with the provision of pedestrian facility (pedestrian way). Whenever people conduct trips to their destinations using busway, there is always a possibility that they will continue their trips on foot to get to their final destination. This is due to the weakness of busway which is unable to perform as door to door service mode.
• No promotion and education process on the importance of using public transportation in metropolitan area and supported by the effort to improve the image of public transportation services in terms of comfort, reliability, and safety.

D. TDM strategy oriented toward mode substitution: shuttle service, carpool, buspool, and telework
• Voluntary carpooling requires residential location of the travelers to have similar routes to the school locations. This is possible since voluntary carpooling can be done at certain points which are the vocal points of meeting between routes from the residential locations with the location of schools, whereas the area of origins of the road users is spread.
• Common trips using the same private vehicle from various travelers requires similar school. This is possible since people are unwilling to conduct similar trips with the same mode but with different schools, even if the schools are close to each other.
• The activities of road users are very diverse so there is a small possibility to have similar after school trip characteristics, since most of the road users have after school activities, such as extracurricular activities and tutorial classes.
• Voluntary trips require an agreement to conduct common trips. In reality, the level of acceptance is low in terms of conducting common trips using the same private mode.
• Low preference toward buspool mode (campus bus) due to bad image about “non private” mode service in terms of flexibility, comfort, and safety.
• Diversity in the distribution of travelers area of origin which makes it difficult to determine the location of buspool shelters that are easily accessed from various residential locations.
• Low level of flexibility in the implementation of telework because it can only be implemented specifically in a certain type of occupation.

4. CONCLUSION
The measurement of the level of TDM strategy effectiveness is like evaluating the performance of TDM strategy. Evaluation can be conducted through two different approaches, i.e. evaluation where the strategy has been implemented and evaluation where the strategy hasn’t been implemented. TDM strategy implementation will be effective if:

1. There are changes in trips behavior that can be explained qualitatively and quantitatively. For example, through the implementation of TDM strategy in a location or city, there is a shift in mode use or trips time which can be explained qualitatively and quantitatively.
2. There is a reduction in the number of trip or reduction in trip length which is measured aggregately from a location or city where the TDM strategy is implemented.

The level of effectiveness of the TDM strategy implementation depends on the level of transportation problem handled by a certain TDM strategy. Study shows that high congestion and private vehicle use are the characters of problems in road segments in the cities of the study area, i.e. Bandung and Jakarta.

The result of the analysis on the implementation and simulation of the TDM strategy implementation can be categorized its level of effectiveness based on level of change in road LOS and the level of change in trip behavior. This categorization can be elaborated based on the following TDM strategies:

1. The implementation of three in one policy is quite effective in influencing changes in the behavior of the traveler, among others are shift in trip route, shift in trip time, the enactment of ridesharing, and the potency of reduction in vehicle volume during the enactment of three in one. However, this policy hasn’t totally capable to influencing behavioral changes from the use of private mode to public transportation.
2. The simulation of the application of progressive parking tariff in the city center is effective in influencing changes in the behavior of the travelers through various responses, i.e. time shift, mode shift, reduction in trip frequency.
3. The implementation of busway is effective in influencing changes in road LOS in some road segments of Daan Mogot Street, although the preference of the travelers toward busway is low so that the potency of a shift is only 30% of the total travelers in the corridor.
4. The simulation of buslane application is effective in influencing the shift in mode choice to buslane and the potency of its ability to reduce the vehicle volume in Soekarno-Hatta street is quite high, so there is a potency to reach an A road LOS (smooth traffic).
5. The implementation of shuttle service is effective in influencing the change in the behavior of the traveler who previously intensively used private vehicle for Jakarta-Bandung trips to the use of “travel” mode with an increasing frequency of trip.
6. Simulation on the provision of carpool and buspool in the area of education is not effective in changing the level of road LOS due to relatively small potency of the shift to this mode. Preference on the use of private mode is quite high.
7. Simulation of telework is quite effective in influencing a change in road LOS (although the change in not too big, from 0.94 to 0.88), and influencing the trip characteristic of the traveler (mode choice, time shift, and reduction in number of trips in peak hours).

The effectiveness of TDM strategy implementation is strongly influenced by the obstacles in implementing the strategy. Some of the obstacles are:

1. Low level of public acceptance on alternative mode. In general, image of “non
private” mode is not interesting and is not capable of providing services similar to private mode.

2. The level of “coerciveness” toward the policy of TDM strategy is not appropriate, e.g. from the regulation that regulates the implementation of the strategy or from the institution with the authority to enact the policy of the TDM strategy.

3. The implementation of TDM strategy which is conducted independently in a certain road segment without any combination which shows a strategy that encourages/discourages trips, such as a type of strategy that leads to the form of *pricing or tax* combined with a type of strategy in the form of alternative mode, mode substitution, or *non motorized* mode.

4. Actualization of travelers who become TDM strategy’s target has not been supported by information on how travel characteristics are done by them. For example, the flexibility of travelers is whether require high flexibility then difficult to use public transportation or there is an easy access to reach closest transit place from residential place of trip user.

5. Level of promotion and education on the importance of using public transportation in metropolitan area which is still low and is not supported by the effort to improve the image of public transportation services in terms of comfort, reliability, and safety.

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